Title: Reliable 2-D carrier profiling with SSRM on InP-based devices
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SSRM (Scanning Spreading Resistance Microscopy) is an intrinsic carrier profiling method based on the contact mode AFM (Atomic Force Microscopy), which is equipped with an electrical measuring unit to measure the local resistance under the probe. It has proven its power for two-dimensional semiconductor device analysis with very high spatial resolution and fully quantitative possibility in the last few years and developed into a commercial available tool. The application of SSRM on InP and related compound material is desirable and has drawn lots of attention. However, the major limitation of the unreliability of measurements hinders it from going further on InP-based devices. On one hand, measuring results with detailed information of devices is only possible in the first scan when the bias is less than the threshold, following by the obvious degradation. On the other hand, measuring results is totally ruined by the current breakthrough when the bias is more than the threshold.

We explored this limitation of unreliability with physical explanation. Electrical field-enhanced Indium anion diffusion through the oxide layer on InP induces the further oxidation at lower bias, and current breakthrough at higher bias, which are related with two negative points in the former SSRM procedure. Furthermore, based on the physical understanding, we developed a new procedure, which seems unexpected at the first sight to overcome this limitation successfully. More precisely, implementation of special kind of highly doped diamond probe with optimized experimental condition in our experiments proved to be the solution with substantial improvement. So now we are able to attain the well-repeated measuring results in the new way, which makes it possible for further quantitative procedures. This paper presents both the physical exploration of the limitation in the old procedure and reliable results attained in the new procedure.

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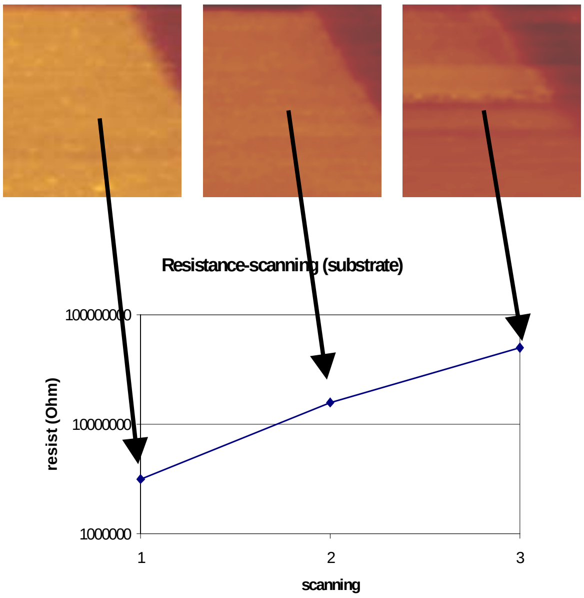
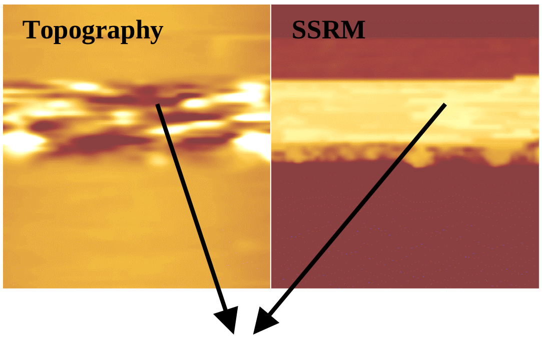
Figure 1 Problem in former SSRM application on InP-based device

(a) Degradation in continuous SSRM result (bias<threshold)



(b) Current breakthrough (bias>threshold)



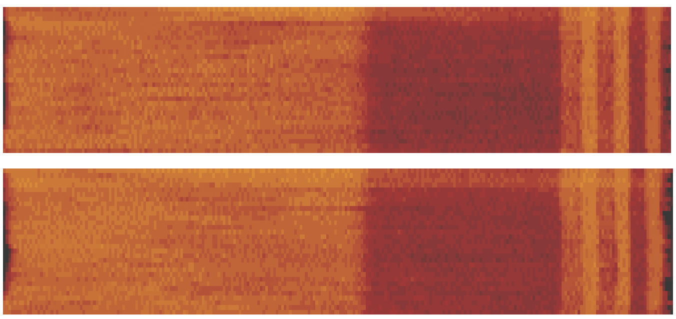
Ruined Topography!
A few **KOhm!**

To be presented in Paper!

- Physical understanding of (a) and (b)
- Diamond probe & optimized condition

Figure2 Improved results in optimized procedure

(a) Two SSRM results from a series of 10 continuous measurements



(b) Further study on repeatability

p-type	repeat %	n-type	repeat %
5.70E+17	18	6.10E+17	21
9.40E+17	14	1.30E+18	15
1.20E+18	10	2.30E+18	13

Repeat.= σ/μ ~ 20%

μ: Average of 10 measurements

σ: Deviation of 10 measurements

Conclusion: SSRM with optimized procedure not only provides detailed information of InP-based devices, but also provides the reliable results with good repeatability, which makes the further development in quantitative procedure possible!